

VEHICLE WASH APPARATUS WITH AN ADJUSTABLE BOOM

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FIELD OF THE INVENTION

The present invention relates generally to automatic vehicle washing systems and, more particularly, to an overhead cleaning platform capable of independent vertical and pivotal  
10 positioning of a plurality of nozzles attached thereto.

BACKGROUND OF THE INVENTION

“Brushless” automated vehicle washing systems are commonly utilized to quickly and efficiently clean vehicles without requiring any hand scrubbing or contact between cleaning  
15 members and the exterior of a vehicle. Brushless vehicle washing systems utilize jets of pressurized cleaning fluid sprayed from a plurality of nozzles to wash away dirt and grime from the exterior surfaces of a vehicle. In one common type of washing system, the nozzles are commonly arranged in a gantry. The gantry either 1) passes over and around the vehicle or 2) is stationary and the vehicle passes through it. In either instance, the nozzles direct jets of cleaning  
20 fluid over most if not the entire exterior surface of the vehicle.

The cleaning efficiency and effectiveness of a vehicle washing system is largely dependent upon two factors: the force at which the pressurized cleaning fluid impinges on the vehicle surface; and the effective area on the vehicle’s surface impacted by the pressurized cleaning fluid. In order to effectively clean the entire surface of a vehicle, the cleaning fluid jet

must impact the adjacent surface with a requisite amount of force in order to dislodge any dirt or foreign matter resident on the adjacent surface. The amount of force per unit area imparted on the adjacent surface is dependent on several factors including the speed and angle at which the jet of cleaning fluid impacts the adjacent surface. As the distance between the nozzle and the adjacent surface increases, the speed of the cleaning fluid decreases; also the jet begins to fan increasing the impact area on the adjacent surface, thereby spreading the impact force over a greater area, and reducing cleaning effectiveness. Accordingly, those parts of a vehicle that are furthest from the nozzles may not be adequately cleaned.

Typically, gantry-type cleaning systems have the most difficulty cleaning the front and rear of a vehicle, since the nozzles located at the sides and top of the gantry normally direct jets of cleaning fluid parallel or at a very shallow angle to the vehicle's front and rear surfaces. Gantry-type washing systems have been developed wherein overhead nozzles are mounted on moveable platforms that (1) pivot to increase the angle of incidence between the fluid jet and the front and rear surfaces of the vehicle, (2) move vertically to decrease the distance between the nozzles and front and rear surfaces, or (3) both pivot and move vertically. The last type of moveable platform is preferred, wherein the platform maybe lowered to get close to front or rear surfaces and pivoted so that the fluid jets impact the surface at a desired angle.

Despite what type of vehicle washing system is utilized, vehicle owners often desire the option of applying additional specialty solutions to their vehicle, such as spot free rinse solutions and clear solutions. Both of these solutions are relatively expensive when compared to the other liquids used during the wash cycle such as water. Accordingly, it is desirable to minimize waste of the specialty solutions, while maximizing coverage of the vehicle's surface. Current art gantry-systems apply these solutions in a number of ways. Using one method, specialty solutions

may be applied through the same high-pressure nozzles that are utilized to apply the cleaning and rinsing solutions. This is undesirable for at least two reasons: one, the specialty solution left in the supply lines must be purged prior to the beginning of the next vehicle wash; and two, the use of a high pressure delivery device might deliver a greater than necessary volume of specialty solution to the vehicle as the gantry traverses the vehicle's length. The result is an inefficient use of the expensive specialty solutions. It is noted that high-pressure delivery of specialty fluid is rarely necessary since specialty solutions are chemical cleaners, not dynamic cleaners; accordingly, the primary goal when applying a specialty solution is simply to obtain complete vehicle coverage.

Another method utilized to apply specialty solutions has been to spray the specialty fluid, often in the form of a foam, onto the sides of the vehicle from discharge openings spaced along vertical dispensing tubes attached to the gantry's side legs. The problem of inefficiency is minimized, since there is no need to purge the dedicated specialty fluid delivery system after each vehicle wash. Unfortunately, these vertically mounted delivery systems have difficulty in delivering solution in a manner that completely covers the top surfaces of a vehicle as there is often little impetus for the applied specialty solution to flow along the horizontal top surfaces of the vehicle, especially when the solution is in the form of a foam.

### SUMMARY OF THE INVENTION

An automatic vehicle washing system is described. In one embodiment, a vertically moveable platform is suspended from a left end while being supported from below on the right end. One or more nozzles are coupled with the platform for spraying jets of cleaning fluid onto the surface of a vehicle. Preferably, the left end of the platform is suspended by a belt, cable or

chain wherein the belt, cable or chain is slideably coupled to the frame and ultimately connected to the right end of the platform for uniform vertical movement therewith. The right end of the platform is supported by a lift actuator. Accordingly, when the lift actuator is actuated to lift the right end of the platform, the belt, cable or chain slides through the frame coupling and is pulled upwards at its junction with the left end, causing the left end to rise in unison with the right end.

In a preferred embodiment, the lift actuator is pneumatic and in communication with a compressor to provide the pressurized air necessary to lift and lower the platform. A pressurized air tank may be provided to serve as a backup in case of a power failure or car wash system malfunction. The air tank may be coupled to a pneumatic switch which automatically opens and allows pressurized air into the lift actuator to raise the platform to its topmost position should power to the compressor be interrupted. In other embodiments, a mechanical lift actuator that uses a lead screw, a drive screw or a drive belt may be used in place of a pneumatic lift.

Typically, the platform comprises a pivoting boom attached to a reciprocating pivotal actuator. A plurality of cleaning nozzles are coupled with the boom and by pivoting the boom; the angle of the fluid jets emanating from the nozzles can be changed. In a first variation of the pivoting boom, mechanical stops are utilized to set the clockwise and counterclockwise pivoted positions of the boom, thereby varying the angle of the fluid jets off vertical. In a second variation of the pivoting boom, the actuator is utilized in conjunction with a guided follower arm. The follower arm permits a certain amount of pivotal movement of the boom depending on the vertical location of the platform. In a third variation of the pivoting boom, the actuator is capable of pivoting to a plurality of selected orientations and holding the boom at that orientation. As necessary, sensors are utilized to determine the desired pivotal orientation of the boom.

The nozzles may be coupled to the boom in any suitable fashion, although in one embodiment the nozzles are coupled to the boom by way of rotating wand assemblies wherein the nozzles are attached to the ends of one or more wands. In another embodiment, nozzle-tipped wands may reciprocate about a pivot point on the boom. The nozzles may also be directly  
5 attached to the boom. The nozzles may be 0-degree nozzles, turbo nozzles, slow rotating turbo nozzles, oscillating nozzles or any other type, or combination thereof.

In the preferred embodiment, one or more low pressure fluid conduits with low pressure nozzles attached thereto are attached to a bottom surface of the horizontal span of the gantry, wherein specialty fluids such as clear coats and spot free rinses may be sprayed on the top of the  
10 vehicle. Additionally, low-pressure fluid conduits may be provided on either leg of the gantry to spray the fluids onto the side of the vehicle. By providing a low-pressure conduit for each specialty fluid, the conduits need not be flushed to change fluids. Furthermore, by utilizing specialized individual conduits, specialty fluid efficiency is enhanced. The overhead and side locations of the conduits ensures accurate and adequate application of fluid to all surfaces of the  
15 vehicle. In one embodiment, clear coat (or drying agent) conduits are located proximate either the front or rear face of the gantry and spot free rinse (or soft water) conduits are located proximate the other of the front or rear face of the gantry, wherein both specialty solutions can be applied in a single pass of the gantry over the vehicle.

In the preferred embodiment a series of turbo nozzles are located on the inside surfaces of  
20 the gantry legs. The nozzles are located at vertical positions generally corresponding to the locations of a rocker panel on a vehicle, the middle of a vehicle and the upper portion of a vehicle. Typically, the plurality of nozzles in each leg are supplied high pressure fluid from a common source and are capable of concurrent operation. One or more solenoids or switches may

be provided wherein the nozzles corresponding to the upper or lower portions of the vehicle may be turned on or off independently of the other nozzles. The integration of the rocker panel nozzles and the side nozzles to the same fluid source permit both a side rinse and rocker panel blast to occur in the same pass.

5           Other aspects, features and details of the present invention can be more completely understood by reference to the following detailed description of the preferred and selected alternative embodiments, taken in conjunction with the drawings, and from the appended claims.

#### BRIEF DESCRIPTION OF THE DRAWINGS

10           Figure 1 is a front elevation of a gantry-type washing system with an automobile positioned in-between the gantry.

          Figure 2 is a fragmentary section taken along line 2-2 of Figure 1.

          Figure 3 is a fragmentary section taken along line 3-3 of Figure 1.

          Figure 4 is an enlarged section taken along line 4-4 of Figure 1.

15           Figure 5 is a fragmentary section taken along line 5-5 of Figure 2 & 3.

          Figure 6 is an enlarged fragmentary section taken along line 6-6 of Figure 5.

          Figure 7 is a section taken along line 7-7 of Figure 6.

          Figure 8 is a section similar to Figure 7 with components in a different position.

          Figure 9 is a fragmentary isometric of the pivoting boom assembly.

20           Figure 10 is a fragmentary isometric illustrating the left end of the pivoting boom assembly.

          Figure 11 is a fragmentary isometric illustrating the right end of the pivoting boom assembly.

Figure 12 is a fragmentary isometric of the pivoting moveable platform illustrating the downward vertical movement of the boom and the operation of the rotating wands.

Figure 13 is a fragmentary isometric of the pivoting moveable platform similar to Figure 12 illustrating the orientation of the pivoting boom after a clockwise rotation.

5        Figure 14 is a fragmentary isometric of the pivoting moveable platform similar to Figure 12 illustrating the orientation of the pivoting boom after a counterclockwise rotation.

    Figure 15 is a fragmentary isometric of a portion of a first alternative pivoting moveable platform that utilizes reciprocating wands and turbo nozzles in place of the rotating wands.

    Figure 16 is a fragmentary top plan view illustration of the alternative pivoting moveable platform showing the spray pattern of the turbo nozzles.

Figure 17 is a fragmentary top plan view illustration of the first alternative pivoting moveable platform showing the range of reciprocating movement of the wands.

Figure 18 is a section taken along line 18 – 18 of Figure 16.

    Figure 19 and 20 are fragmentary isometric views looking at the outside and inside respectively of the left leg of the gantry in an alternative tilting mechanism.

Figure 21 is top view of the bay of a vehicle wash system illustrating the wheel stops and vehicle guide members.

Figure 22 is an enlarged isometric view of the wheel stop and the guide platform of the outside vehicle guide member.

20        Figure 23 is an enlarged fragmentary section taken along lines 23-23 of Figure 2 illustrating a series of turbo nozzles.

    Figure 24 is an enlarged section similar to Figure 4 illustrating a variation in the configuration of the low pressure delivery tubes.

Figures 25 and 26 are side views of one leg of the gantry with cut away portions illustrating a pivoting boom centering mechanism according to one variation of the present invention.

Figure 27 is a fragmentary isometric of a portion of a variation of the first alternative moveable platform that utilizes reciprocating wand attached to a twin tube boom.

Figure 28 is a fragmentary isometric of a portion of another variation of the first alternative moveable platform that utilizes reciprocating wand attached to a twin tube boom.

Figures 29 and 30 are fragmentary isometrics of a portion of a second alternative pivoting moveable platform that utilizes turbo nozzles attached directly to a twin tube boom in place of the rotating or pivoting wand assemblies.

Figures 31 and 32 are sectional views of the second alternative pivoting moveable platform taken along lines 31-31 and 32-32 of Figures 29 and 30 respectively.

Figure 33 is a flow diagram illustrating the operations performed during a four pass vehicle wash cycle.

Figure 34 is vertical section of a turbo nozzle.

Figure 35 is an isometric view of a rotating nozzle member of a turbo nozzle.

Figure 36 is a section of the rotating nozzle member taken along line 36-36 of Figure 35.

Figure 37 is a section of the turbo nozzle taken along line 37-37 of Figure 34.

Figure 38 is a section of the rotating turbo nozzle taken along line 38-38 of Figure 34.

Figure 39 is a section of the turbo nozzle taken along line 39-39 of Figure 34.

Figure 40 is a section similar to Figure 39 illustrating a variation of the rotating nozzle member at line 39-39.



Figure 41 is a partial section of a prior art fast rotating turbo nozzle taken along lines 36-36 of Figure 34 having a single inlet orifice into the nozzle body.

Figure 42 is a partial section of a slow rotating turbo nozzle taken along lines 36-36 of Figure 34 having four inlet orifices into the nozzle body.

5 Figure 43 is a exploded isometric view of an oscillating nozzle.

Figure 44 is a fragmentary isometric of an oscillating nozzle showing atypical spray pattern of an oscillating nozzle

### DETAILED DESCRIPTION

10 A gantry-type vehicle washing system in accordance with the present invention incorporates a single pneumatic cylinder to lift and lower both sides of an overhead cleaning platform in cooperation with a drive belt, eliminating the need to coordinate movement between two lifting mechanisms located on either ends of the platform. The platform includes a reciprocating pivotal actuator that is coupled with a boom such that the boom can be pivoted. A plurality of fluid delivery nozzles are coupled to the boom. Advantageously, the pivotal movement of the boom is operationally independent from the vertical movement, thus permitting 15 greater adaptability of the washing system to vehicles of differing profiles. Furthermore, one or more low-pressure conduits are disposed lengthwise across the top span of the gantry and vertically along the legs of the gantry with nozzles spaced thereon to deliver specialty fluids to the top and sides of the vehicle. Nozzles located near the end of the manifolds may be angled inwardly slightly as to insure the specialty fluids impact the vehicle. One set of conduits for a 20 first type of fluid, such as a clear coat, may be located near one face of the gantry and another set of conduits for a second type of fluid, such as a spot free rinse, may be located near the other face of the gantry. Advantageously, during a single pass of the gantry over the vehicle, the first

type of fluid may be applied to the vehicle as the one face passes overhead, and the second type of fluid applied to the vehicle as the other face passes overhead shortly thereafter. Finally, a switch or solenoid is provided, wherein the fluid supply to the upper high pressure nozzles on each gantry leg can be shut off without interrupting the fluid supply to the lower high pressure nozzles. Additionally, another switch or solenoid is provided wherein both the upper and lower nozzles on a gantry leg can be turned off during a wash cycle while the high pressure nozzles associated with the moveable platform can continue to operate. Accordingly, depending on the profile of the vehicle being washed, the upper nozzles can be turned off when their fluid jets would not impact the side of the vehicle and both the upper and lower nozzles can be turned off when the gantry is in front of or behind the vehicle such as when the front or rear surfaces of the vehicle are being washed.

### **A First Embodiment**

A first embodiment of a gantry type vehicle washing system 100 in accordance with the present invention is illustrated in Figures 1-14 and 21-26.

Referring to Figure 1, the gantry type vehicle washing system 100 comprises a gantry structure 105, gantry guide rails 110, and vehicle guide members 112. Generally, the gantry structure 105 includes the plumbing and mechanicals necessary to effectively clean a vehicle 120, such as an automobile, truck, van or SUV, as will be described in detail herein. In the preferred embodiment, the gantry structure 105 moves reciprocally along the length of a vehicle on gantry guide rails 110. Rail wheels and a motor (neither shown) are contained within the gantry structure 105 to propel it back and forth. It is to be understood that in alternative embodiments, movement of the gantry structure relative to the vehicle being cleaned could be accomplished in any conceivable manner with or without the use of rails 110 that would be

obvious to one of skill in the art. For instance, automobile 120 may merely drive through a fixed and stationary gantry structure. In another instance, the gantry 105 could be suspended from a ceiling and slide or roll along guides provided therein. Vehicle guide members 112 are also provided to help the driver of a vehicle properly position the vehicle under the gantry 105, at a proper distance from the sides of the gantry 105. An example of a gantry structure of the general type described is shown in United States Patent No. 5,076,304 which is of common ownership with the present invention and which is hereby incorporated by reference.

As illustrated in Figures 21 and 22, inside and outside vehicle guide members 112, 113 and 114 are provided. The left and right outside guide members comprise both raised tubes 112 that run generally parallel to the gantry guide rails 110 and a guide platform 113 disposed on the inside of the raised tubes 112 that has inside vertical surfaces that are angled inwardly towards a set of front tire stops 115. A vehicle 120 enters the car wash by driving between the raised tubes 112. If the vehicle 120 approaches the front tire stops 115 too far to one side, the inside vertical surface of one of the guide platforms 113 impacts the outside of the vehicle's front tire and guides the vehicle 120 towards the tire stops 115. The inside guide member 114 comprises a generally V-shaped raised tubular structure that is centered relative to the inside surfaces of the left and right legs of the gantry with the vertex of the "V" facing the vehicle wash entrance. Accordingly, if the vehicle 120 strays to the left or right as it approaches the tire stops 115, the inner guide member 114 impacts the inside of the vehicle's front tire and guides the vehicle back towards a center position. As can be appreciated, the shortest distance between the vertical surfaces of the outer guide member's guide platform 113 must be greater than the widest track of the type of vehicle the vehicle wash is designed to service.

In a prior art wash system with only an outside guide member, a vehicle with a small track width can be positioned within the wash in such a manner such that the distance between the nozzles on one leg of the gantry and one side of the vehicle is much smaller than the distance between the nozzles on the other leg and the other side of the vehicle. The inside guide member 114 has a maximum width at the opening of the “v” shape that is smaller than the shortest distance between the inside surfaces of the tires on a vehicle having the smallest track that the vehicle wash system is designed to service. Advantageously, a vehicle with a small track width that is too far to the left or the right upon entering the vehicle wash will be guided by the inside guide member towards a center position between the left and right legs of the gantry, thereby minimizing the difference in distances between the side nozzles and the respective side surfaces of the vehicle.

Referring again to Figure 1, the typical gantry structure 105 is in the form of an inverted-U having a left leg 205, a right leg 210, and a top span 215. Located along the front side of the gantry structure 105 is a dryer apparatus 220 designed to blow high velocity air onto a vehicle as the gantry 105 moves along and over the vehicle after the wash cycle has been completed. The high velocity air is generated by one or more fans (not shown) contained within the dryer apparatus housing and blown through ducting 222 and out vents 224 located on the three inside surfaces of the gantry 105. Alternative embodiments of the washing system 100 may not incorporate a dryer apparatus 220 or the apparatus 220 may be separate from the gantry structure 105.

Referring to Figures 2 & 3, a plurality of turbo nozzles 230 are distributed on the inside surface of the left and right legs 205 & 210 of the gantry structure 105 and are located in a vertical line between the front and rear of each of the legs in the lower portion of the legs

corresponding generally to the side surfaces of a vehicle. The advantages of turbo nozzles over traditional 0 degree nozzles will be discussed in detail infra. Suffice it to say, the fluid jet from each turbo nozzle more effectively cleans a given area of the vehicle surface than traditional nozzles, thereby either reducing (1) the number of nozzles required or (2) the need to have the nozzles attached to rotating wand assemblies. It is to be appreciated that both turbo nozzles and traditional zero degree nozzles as described herein are high pressure nozzles wherein fluids supplied to these nozzles are under pressures typically in excess of 500 pounds per square inch (psi) to upwards of 1000 psi. The high pressure nozzles are typically utilized in a vehicle wash to supply a cleaning solution, which is typically water, to the surface of the vehicle in such a manner that the dirt and debris is dynamically removed from the vehicle's surface.

A preferred configuration of the plurality of turbo nozzles 230, as illustrated in Figure 23, comprises several rocker panel blaster nozzles 230A, several middle nozzles 230B for cleaning the side of the automobile and several upper nozzles 230C for cleaning the sides of the body that are typically vertically located above the hood. The rocker panel blasters 230A are typically high volume turbo nozzles that can effectively dislodge the types of debris, such as mud, that can accumulate on the rocker panels of a vehicle between washes. The middle and upper turbo nozzles 230B and 230C typically spray a lower volume of solution than the rocker panel blasters 230A since the middle and upper portions of a vehicle typically do have as much debris on them as the rocker panels. Generally, the plurality of turbo nozzles 230 located in each leg 105 of the gantry are connected in series to a manifold 236 and are turned on or off through a solenoid valve 237 located at the base of the manifold proximate a location where the manifold joins the solution supply line. Accordingly, the control system can control the supply of solution to the plurality of nozzles 230 depending on the operation being performed during a particular wash

cycle. Additionally, a second solenoid valve 238 is provided along the manifold 236 between the middle and upper nozzles 230B and 230C such that the control system can turn the flow of solution to the upper nozzles 230C off or on depending on the location of the gantry relative to the side of a vehicle. Accordingly, the upper nozzles 230C can be turned off when the gantry is traveling over the hood or trunk of the vehicle since the jets emanating from these nozzles would not impact the side of the vehicle or could be turned on when traveling over the cabin of the vehicle which is higher on the sides.

A variation of the plurality of turbo nozzles 230 is contemplated wherein a third solenoid valve is specified to selectively control the flow of cleaning solution to the rocker panel blasters independent of both the middle and upper nozzles. It is to be appreciated that although the series of nozzles described herein are connected to a manifold in series, each of the sets of rocker panel, middle and upper nozzles can be attached to the manifold or multiple manifolds in parallel as would be appreciated by someone of ordinary skill in the art with the benefit of this disclosure.

Additionally, referring to Figures 2 and 3, several low pressure presoak solution nozzles 242 are distributed on the inner surface of the legs and the top span. These nozzles are typically configured to spray a detergent solution onto the vehicle as the gantry 105 passes over it. The key consideration in locating the presoak nozzles 242 is to insure that the vehicle can be completely covered in presoak solution. The relative force per area at which the presoak solution impacts the surface of the automobile is generally not important. Low pressure nozzles, such as the presoak nozzles and specialty solution application nozzles (as will be described below), typically operate at pressures between 50 and 150 psi. Variations of the invention may

incorporate any number of different configurations of side nozzles to perform both the presoak and wash cycles as would be obvious to one of skill in the art with the benefit of this disclosure.

Figure 4 is a view looking up at the inside of the top span 215. Two low-pressure fluid delivery tubes 235 (or manifolds) are located proximate the front and rear sides of the top span 215. Each of the fluid delivery tubes 235 is in operative connection with a reservoir of specialty fluid and a low-pressure pump (both not shown). Several low-pressure nozzles 237 & 239 are distributed on each of the low-pressure fluid delivery tubes 235 to spray specialty solutions, such as a clear coat, a soft water rinse or a spot free rinse onto a vehicle. As with the application of presoak solution, the primary concern in applying a clear coat is obtaining complete coverage of the surface of a vehicle with relatively little concern regarding the force at which the solution impacts the surface when compared to dynamic application of cleaning solution by the high pressure nozzles. Although still low pressure nozzles, the spot free rinse is typically applied at slightly higher pressures (around 100 psi) using nozzles that have a greater volumetric capacity than the clear coat nozzles in order to induce a “squeegee” effect to ensure complete coverage of the vehicle. The low pressure nozzles 237 located proximate the intersection between the inner surface of the left and right legs and the inside of the top span may be angled inwardly towards the side surfaces of the vehicle so that the specialty solution is sprayed thereon. Depending on the embodiment, additional specialty solution nozzles maybe located on the inside of the right and left legs 205 & 210 to insure complete coverage of the side surfaces. Although two low-pressure fluid delivery tubes 235 are shown, it is understood that alternative wash systems may have more or fewer low-pressure fluid delivery tubes 235 located on the inside of the top span 215.

In a variation of the low pressure delivery tubes, as shown in Figure 24, a clear coat or drying agent delivery tube 235A is located proximate the front or rear edge of the top span 215, as well as, the corresponding edge of the legs 205 & 210, and a spot free rinse or soft water delivery tube 235B is located proximate the opposite edge of the top span 215. In operation, as the gantry passes over the vehicle, the clear coat or drying agent is first applied to the surface of the vehicle and has time to soak until the other edge of the gantry passes overhead and the spot free rinse or soft water solution is applied to the vehicle. Advantageously, the application of both specialty fluids can be performed in a single pass instead of two passes that would typically be required using prior art vehicle wash systems.

Again referring to Figure 4, as well as, Figures 5 & 9, a moveable platform 240 is located at the proximate front-to-rear center of the inside or bottom of the top span 215 and is substantially coextensive with the top span 215. The moveable platform 240 comprises: (1) a pivoting boom 245; (2) two rotating wand assemblies 250 attached to the pivoting boom 245; (3) a reciprocating rotary pivotal actuator 260 pivotally attached to the pivoting boom 245; and (4) a mounting system to secure the moveable platform 240 to the gantry 105.

The rotating wand assemblies 250 each typically comprise three hollow wands 252 radiating from a rotating manifold 254. Each wand 252 is adapted to carry pressurized cleaning fluid therein and one or two zero-degree nozzles 256 are generally attached to its distal ends. In other variations, an oscillating nozzle or a turbo nozzle may be specified. The wand assemblies 250 are normally orientated on the pivoting boom 245 parallel to the ground such that the nozzles 256 spray a substantially vertical fluid jet. The rotating manifold 254 is both attached to and in fluid communication with a bearing seal element 258 that permits both rotational motion and the transfer of high pressure cleaning fluid to the manifold 254. Another end of the bearing



seal element 258 is coupled with the shaft of a unidirectional motor 253 either directly or through a gear set 255. The unidirectional motor 253 is configured to facilitate the rotation of the wand assembly 250 at a predetermined speed. Additionally, a high-pressure fluid conduit 265 for transporting cleaning fluids is coupled with the bearing seal member 258. Various alternative  
5 embodiments of the cleaning fluid delivery systems are contemplated as would be obvious to one of ordinary skill with the benefit of this disclosure. One embodiment is described in detail later that utilizes reciprocating wands with turbo nozzles attached to their ends. Other variations, for example, might include stationary turbo nozzles disposed along the length of the pivoting boom 245, wherein the boom 245 may be adapted to serve as a cleaning fluid delivery conduit.

Referring to Figures 5 and 9, the moveable platform 240 is vertically supported in the gantry structure 105 at its right end by a pneumatic lift 270 in operative connection with an actuator bracket 275. The reciprocating pivotal actuator 260 is fixedly attached to the actuator bracket 275, and the right end of the pivoting boom 245 is attached to the shaft of the reciprocating pivotal actuator 260. A clamp member 280 extends perpendicularly from the  
10 actuator bracket 275 and a first end of a linear drive belt 285 is anchored thereto. From the first end, the drive belt 285 extends: downwardly and through a first idler pulley 290 near the base of the right leg 210; upwardly and through a second idler pulley 292 located at the top of the right leg 210; horizontally along the top span 215 and through a third idler pulley 294; and downwardly until terminating at a second end that is anchored to an inverted T-shaped clamp  
15 member 295 located at the left end of the moveable platform 240. The left end of the pivoting boom 245 is pivotally attached to the T-shaped clamp 295. Accordingly, the left end of the moveable platform 240 is suspended from the drive belt 285. In the preferred embodiment, the drive belt 285 is comprised of a Kevlar reinforced polymeric material, although in alternative  
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embodiments, the belt may be comprised of any number of materials having the necessary strength characteristic to support the moveable platform 240. The belt may be replaced altogether with a suitable cable or chain. Additionally, any number of configurations are possible for routing the belt 285 from one side of the moveable platform 240 to the other.

5 Any weight imbalances in the rotating wand assemblies 250 may cause lateral forces to be induced in the moveable platform 240. To prevent unwanted lateral movement of the moveable platform 240 caused by the lateral forces, the moveable platform 240 is constrained by right and left slide members 305 that are each disposed between and slideably attached to two vertical guide rails 310 that extend a substantial portion of the length of each gantry leg (best  
10 seen in Figures 4, 10 & 11). The pivoting boom 245 passes through a vertically elongated bore 312 in each slide member 305. The elongated bores 312 have widths slightly greater than the diameter of the pivoting boom 245, thereby constraining the moveable platform 240 from any substantial lateral movement. In the preferred embodiment, each slide member 305 comprises two additional bores 314 & 316. Electrical cabling (not shown) from the unidirectional motors is  
15 typically routed through middle bore 316 on the right slide member 305, and the cleaning fluid conduit is routed through the upper bore 314 on both slide members 305. The slide members 305 are fabricated from a polymeric material such as Derlin® or nylon, but any suitable material may be utilized. Any number of alternative structures may be utilized to constrain the lateral movement of the moveable platform with or without the use of slide members and/or guide rails  
20 as would be obvious to one of ordinary skill in the art.

To lower the moveable platform 240 as shown in Figure 12, the pneumatic lift 270 is retracted, lowering the right side of the moveable platform 240. Simultaneously, the drive belt 285 travels through the idler pulleys 290-294 as indicated, increasing the length of the portion of

the drive belt located between the inverted T-shaped clamp 295 and the third idler pulley 294, thereby lowering the left side of the moveable platform 240 a corresponding amount to that of the right side. To raise the moveable platform 240, the pneumatic lift 270 is extended, pushing the right end of the moveable platform 240 upwardly and pulling the drive belt 285 as to shorten the length of the portion between the inverted T-clamp 295 and the third idler pulley 294 to pull the left end of the moveable platform 240 upwardly.

Depending on the design and construction of the vertical lift system, a malfunction within the vehicle wash system, such as a compressor failure, a power failure, or an air leak, may cause the pneumatic lift 270 and the moveable platform 240 to lower, possibly on to the surface of a vehicle that is being washed. Accordingly, the preferred embodiment incorporates one or more fail-safe features that in the event of a malfunction, cause the moveable platform 240 to rise to the top of the gantry 105 and lock in its retracted position until normal operation can be restored. A pressurized air tank 320 (Figure 5) is pneumatically coupled by way of one or more air hoses (not shown) with the pneumatic lift 270 providing a reservoir of compressed air to facilitate emergency operation of the lift 270 in the event of a malfunction. In one embodiment, a solenoid coupled with a pneumatic switch (neither shown) may be utilized to trigger the raising of the moveable platform 240. The switch may be triggered by a power failure or by a drop in pressure in the line supplying the actuator to below 65 psi (pounds per square inch). In operation, after a malfunction, the solenoid trips the normally closed pneumatic switch permitting pressurized air to travel from the air tank 320 to the pneumatic lift 270, causing the lift 270 to rise. As long as sufficient pressurized air remains in the tank 320, the moveable platform 240 will be retained in the retracted position. It is understood, that a wide variety of switch mechanisms as would be obvious to one of ordinary skill may be utilized to cause the moveable

platform 240 to rise in the event of a power failure and the one described herein is merely illustrative.

A latch or locking mechanism 325 may also be utilized in certain embodiments to retain the moveable platform 240 in the retracted position after a power failure. One type of locking mechanism 325 is illustrated in Figures 6-8. A latch plate 330 extends vertically from the actuator bracket 275. At the top of the latch plate 330, a horizontal tongue 332 extends leftwardly. The top and bottom surfaces 336 & 334 of the tongue 332 are beveled. When the moveable platform 240 is fully retracted, the tongue 332 is located adjacent to a solenoid actuator 340. Preferably, the solenoid actuator 340 is pneumatic, wherein compressed air is routed into the solenoid when power to it is interrupted, causing a shaft 342 to extend rightwardly from the solenoid body. Alternatively, the solenoid may be spring loaded, wherein the spring biases the shaft 342 to the right. Attached to the end of the solenoid shaft 342 is a latch member 344 having a rightwardly extending tongue 346 corresponding to the leftwardly extending tongue 332. The rightwardly extending tongue 332 comprises beveled upper and bottom surfaces 348 & 349.

During a vehicle wash malfunction, the electrical current to the solenoid 340 is interrupted and compressed air encourages the solenoid shaft 342 into its extended position. If the moveable platform 240 is already in its retracted position, the upper surface 348 of the rightward extending tongue 346 will slide below and support the bottom surface 334 of the latch plate's leftwardly extending tongue 332, effectively locking the moveable platform 240 in its retracted position. If the moveable platform 240 is not retracted at the time of failure, the top beveled edge 336 of the leftwardly extending tongue 332 meets the rightwardly extending tongue 346 as the moveable platform 240 is raised, causing the solenoid's biased shaft 342 and

the rightwardly extending tongue 346 to move leftwardly. Once the rightwardly extending tongue 346 is pushed back enough, the leftwardly extending tongue 332 passes it as the moveable platform 240 is returned to its retracted position, and the top surface 348 of the rightwardly extending tongue 346 is encouraged under the bottom surface 334 of the leftwardly extending tongue 332, thereby locking the moveable platform 240 in the retracted position.

Referring primarily to Figures 9-11, the reciprocating pivotal actuator 260 and other associated structure relating to the pivoting or rotating of the pivoting boom 245 will now be described. As was described above it is useful to pivot the boom 245 to change the direction of the fluid jets emanating from the nozzles 256 at the distal end of the wands 252 in order to more effectively clean the various surfaces of a vehicle. The shaft of the reciprocating pivotal actuator 260 is coupled with the pivoting boom 245 on the right end of the moveable platform 240. The pivoting boom 245 passes through the elongated bores 312 of the right and left slide members 305, both of which permit the boom 245 to pivot freely. On the left end of the moveable platform 240, the inverted T-clamp 295 is pivotally attached to the boom 240 by way of a bearing (not shown), thus the inverted T-clamp 295 may maintain its positioning, ensuring proper alignment between the clamp 295, the drive belt 285 and the third idler pulley 294. Attached to the distal ends of the inverted T-clamp's arms are two proximity sensors 350. Adjacent and just to the right of the sensor faces are two or more flat sensor plates 355 that radiate from the pivoting boom 245 at predetermined locations. In variations of the vehicle wash system, the sensors and associated sensor plates may be located in any number of suitable locations, such as the right side of the pivoting boom proximate the pivoting actuator. Depending on rotational orientation of the pivoting boom 245 relative to the inverted T-clamp 295, the plates 355 may cover the face of one of the sensors 350 causing the covered sensor 350

to transmit a signal to the control system (not shown). Based on the received signal, the control system can determine the pivotal position of the boom 245 (i.e. whether the boom is pivoted clockwise or counterclockwise) and activate or deactivate the reciprocating pivotal actuator 260 accordingly. It is to be appreciated that any number of sensor configurations can be utilized by a mechanical or computerized control system to determine the relative pivotal orientation of the boom 245. Additionally, in some embodiments the need to use sensors 350 to determine the position of the boom may be obviated by the use of advanced reciprocating actuators that are capable of accurately pivoting the boom 245 a specified amount based only on the appropriate input from the control system.

Referring to Figure 11 illustrating the right end of the moveable platform 240, the base of a short c-shaped channel 360 is adjustably mounted against the vertical surface of the actuator bracket 275 at a lengthwise location between the right slide member 305 and the reciprocating pivotal actuator 260. The legs of the c-shaped channel 360 extend over and under the corresponding section of the pivoting boom 245. A radial arm 365 is attached to the pivoting boom 245 at the same proximate location along the boom 245 that the legs of the c-channel 360 extend over the boom 245. When the moveable platform 240 is in its retracted position with the nozzles 256 aimed vertically downwardly, the radial arm 365 is generally centered between the planes formed by the inside surfaces of the upper and lower legs. Together, the radial arm 365 and the c-channel 360 serve to control the clockwise and counterclockwise positions of the pivoting boom 245. For instance, if the pivotal actuator is engaged to rotate the boom 245 clockwise, movement of the boom is stopped when the radial arm impacts the lower arm of c-channel 360. Likewise, if the pivotal actuator is engaged to rotate the boom 245 counterclockwise, movement of the boom is stopped when the radial arm impacts the upper arm

of c-channel 360. The amount of pivotal movement in either direction may be adjusted by moving the c-channel inwardly or outwardly relative to its mounting location on the actuator bracket. Accordingly, if the c-channel is moved away from the mounting bracket, the radial arm will impact the ends of the c-channel arms sooner lessening the pivotal movement. Conversely, by mounting the c-channel as close as possible to the bracket, the radial arm must pivot further before impacting the ends of the c-channel. Ideally, the c-channel and radial arm are adjustable to permit between 60 and 90 degrees of pivotal movement in both the clockwise and counterclockwise directions. Stops to limit pivotal motion, such as the c-channel and radial arm assembly, may not be utilized in all embodiments of the invention. For instance, an advanced reciprocating pivotal actuator can be utilized that is capable of precisely controlling the amount pivotal movement of the boom obviating the need for external mechanical stops.

In general, the pivotal movement of the pivoting boom 245 is independent of the vertical position of the moveable platform 240 thus permitting the car wash system 100 to adjust to vehicles of a number of different profiles. This is different from many prior art systems wherein the tilt of a moveable platform to which overhead nozzles are attached depended directly on the vertical position of the movable platform. That having been said, certain embodiments may limit the pivotal movement of the moveable platform 240 until it is lowered vertically a minimum distance to prevent the distal ends of the rotating wands 252 from impacting the top span 215 of the gantry structure 105.

In a variation of the pivoting mechanism, the reciprocating pivoting actuator 260 is actuatable to pivot the pivoting boom 245 either to the right or the left from the centered position; however, it is not configured to return the boom 245 to the centered position once it has been pivoted, nor is it configured to hold the boom in the centered position. To accomplish these

tasks a centering mechanism, as illustrated in Figures 25 and 26, is provided wherein the pivoting boom 245 is returned to its centered position when the moveable platform 240 is retracted. The centering mechanism comprises a pair of spaced parallel tracks 244 that are positioned on either side of the pivoting boom 245. At a common vertical location, the two tracks 244 diverge from each other at an acute angle, such that the two tracks when viewed together have an inverted Y-shape. The centering mechanism also comprises a downwardly extending arm 246 that is fixedly attached to the pivoting boom 245 at a distal end and has a wheel 248 rotatably attached to its proximal end. The wheel 248 is normally positioned between the spaced and parallel tracks 244 when the pivoting boom 245 is in its retracted position as shown in Figure 29. It can be appreciated that in this position the boom 245 cannot be pivoted but it can be freely moved up or down as part of the moveable platform 240 to adjust the distance between the nozzles 256 or 405 attached therewith and the top of a vehicle. Once the wheel 248 is lowered below the location, where the tracks 244 diverge the reciprocating pivoting actuator 260 can be activated to pivot the boom 245. Referring to Figure 26, as the boom 245 is retracted from the lowered and pivoted position, the wheel 248 impacts one of the divergent tracks 244 and guides the pivoting boom 245 back into its centered position.

The pivoting operation of the moveable platform 240 will now be briefly described. First, to clean the front end of a vehicle as shown in Figure 13, the gantry 105 is moved into a position forwardly of the front end of the vehicle. Next, the moveable platform 240 is lowered vertically at least the minimum amount. At this point, a pneumatic switch is opened by the control system, permitting compressed air to enter the proper chamber of the reciprocating pivotal actuator 260, causing the pivoting boom 245 to rotate clockwise. The pivoting boom 245 will continue to pivot until stopped when the radial arm 365 impacts the lower arm of the c-



channel 360. It is noted that the moveable platform 240 may be moving vertically while the boom 245 is pivoting. When the front end cleaning cycle has been completed, the moveable platform 245 is raised and the pivoting boom 245 is pivoted counterclockwise back into its retracted position. To clean the rear surfaces of the vehicle, the gantry 105 is moved behind the vehicle and the process is repeated except that the boom 245 is pivoted counterclockwise until the radial arm 365 impacts the upper c-channel arm.

Given the manner in which the moveable platform 240 may be raised and lowered vertically combined with the independent pivotal movement of the boom 245, it is appreciated that depending on the control system utilized by the washing system 100, the operation of the moveable platform 240 may be customized to any number of vehicles to maximize cleaning effectiveness. First, The vertical position of the nozzles may be adjusted for the height of the vehicle being washed, and to account for the different heights between a hood/truck and the roof of the cabin. Accordingly, the nozzles can be maintained at the optimum distance from the upper surface of the car to maximize cleaning effectiveness. Second, the boom 245 can be pivoted to an angle of 60-90 degrees so the nozzles can directly face the front and rear ends of the vehicle and more effectively clean the ends when compared to prior art wash systems that spray the front and rear surfaces at shallow acute angles. While jets of fluid are sprayed onto the front or rear ends at angles that are nearly perpendicular, the platform may be moved up and down as appropriate to ensure the entire front surface is washed. Accordingly the front and rear ends of a high profile vehicle such as an SUV may be cleaned as effectively as a lower profile vehicle such as a sedan. As the gantry 105 moves rearwardly, jets of fluid are sprayed on the hood. As the gantry 105 moves over the windshield, the pivoting boom 245 may be pivoted to an angle whereby the nozzles directly face the windshield. As jets of fluid are sprayed onto the windshield at

approximately a right angle, the gantry moves towards the top-rear of the windshield and the platform 240 rises as necessary to maintain a predetermined spacing between the nozzles and the windshield surface. As the gantry 105 moves over the roof of the car, the pivoting boom 245 pivots back to a position where the wands are horizontally disposed.

5 As has been discussed above, the exemplary embodiments described herein are not intended to limit the scope of the invention. Many alternative embodiment gantry-type vehicle wash systems have been contemplated that retain one or more of the innovative aspects of the invention. A first alternative embodiment is illustrated in Figures 15-18, wherein the rotating wand assemblies are replaced with reciprocating wands that utilize turbo nozzles. A second  
10 alternative embodiment is illustrated in Figures 29-32, wherein turbo or oscillating type nozzles are affixed directly to a pair of parallel and spaced boom tubes. A third alternative embodiment is illustrated in Figures 19 and 20, wherein the amount (or degree) of tilt of the pivoting boom is controlled based on the vertical position of the pivoting boom.

#### **A First Alternative Embodiment**

15 With reference to Fig. 17, the reciprocating wand assembly 400 of a first alternative embodiment is shown mounted on the pivoting boom 245 which has been adapted to serve as a high pressure fluid delivery manifold as well. The pivoting boom 245 is connected to a supply (not shown) of pressurized liquid to be sprayed onto the vehicle and supports three equally spaced reciprocating wands 410 through vertical hollow pivot shafts 420 associated with each  
20 wand 410. The shafts 420 are mounted on appropriate bearings 425 that allow the wands to reciprocate in a horizontal plane through their operative connection with a drive/link system 415. Each hollow pivot shaft is in fluid communication in a conventional manner with the interior of the pivoting boom 245 so that liquid within the manifold boom can pass from the manifold into

the interior of the hollow pivot shaft. Each pivot shaft is, in turn, in fluid communication with the interior of each wand 410, which is also of hollow tubular configuration, so that liquid from the manifold can be passed into the wands in equal quantities. Each wand has a turbo nozzle 405 mounted at each end thereof with the nozzles being directed downwardly to direct a cyclical conical spray of fluid in a downward direction and in a manner to be described in more detail hereafter.

Each pivot shaft 420 has a crank link 430 fixed thereto adjacent to its uppermost end with the crank link being keyed to the shaft so that pivotal movement of the crank link in a horizontal plane about the vertical axis of the pivot shaft causes the pivot shaft 420 and the connected wand 410 to reciprocate in a corresponding manner. The drive/link system 415 includes a drive member 435 and a plurality of crank and link members that interconnect the drive member with the reciprocating wands. In the first alternative embodiment, the drive member is an electric motor having an output shaft (not seen) operably connected through a gear box 440 to a primary crank arm 445 that is rotated in a horizontal plane about a vertical output shaft 450 of the gear box. The distal or free end 455 of the primary crank arm is pivotally connected to a drive link 460 whose opposite end is pivotally connected to a bifurcated secondary crank arm 465 that is keyed to the vertical pivot shaft 420 of the first reciprocating wand 410, i.e. the wand that is closest to the motor 435.

As will be appreciated, when the drive motor 435 is driven in either direction, the primary crank arm 445 rotates and causes the drive link 460 to pivot in a horizontal plane while being slid reciprocally within the horizontal plane along a path parallel to the length of the pivoting boom 245. This sliding and reciprocating movement of the drive link causes the secondary bifurcated crank arm 465 to pivot back and forth in the same horizontal plane about

the vertical shaft 420 of the first reciprocating wand thereby causing that vertical shaft, the connected wand and the associated crank link 430 to reciprocate in a corresponding manner. The free end 470 of the first crank link is pivotally connected to a first connecting link 475 whose opposite end is pivotally connected to the free end of the crank link 430 of the second wand 410 (i.e. the wand closest to the first wand). A second connecting link 480 longitudinally aligned with the first connecting link 475 is pivotally connected to the free end of the second crank link at the same location as the first connecting link and has its opposite end pivotally connected to the crank link 430 associated with the third wand 410 or the wand that is furthest removed from the drive motor 435.

It is important to appreciate that the crank links 430 and the bifurcated secondary crank arm 465 are relatively short so that the connecting links 475 and 480, which interconnect adjacent crank links, are positioned parallel to and are closely adjacent to the pivoting boom 245. In the preferred embodiment, the connecting links and crank link are no more than 3/4 of an inch from the manifold and preferably about 1/2 inch. This provides for a very compact system for reciprocating the wands 410 as will be described hereafter. The compactness is important inasmuch as the manifold, as described previously, may be mounted to pivot about its longitudinal axis or an axis parallel thereto so that the spatial orientation of the wands 410 can be changed between horizontal and vertical or any angle therebetween, and the close proximity of the links and crank arms to the manifold allows this to be accomplished without an unwieldy mechanism.

In operation, it will be appreciated that as the drive motor 435 is operated, its output shaft causes the primary crank 445 to rotate thereby causing the connected drive link 460 to reciprocate effecting reciprocation of the secondary bifurcated crank arm 465 in a horizontal

plane which, in turn, causes the connected pivot shaft 420 of the first wand 410 to pivot about its longitudinal axis a corresponding amount. That same pivotal movement is transferred to the first crank link 430 with the pivotal movement of the first crank link being transferred from the first crank link to the second crank link through the first connection link 475 and from the second crank link 430 to the third crank link 430 through the second connection link 480. Each reciprocating wand is thereby enabled to pivot in unison in a horizontal plane as illustrated best in Fig. 17. In Fig. 17, it can be seen from the full line and dashed line positions of the reciprocating wands that the associated nozzles are pivoted back and forth along an arc "A" a predetermined degree which, when associated with the spray pattern of the nozzles on the reciprocating wands as described later, provide complete coverage of the surface of a vehicle being washed with the apparatus.

As best appreciated by reference to Figs. 16 and 18, each turbo nozzle 405 emits a beam or stream of liquid in a straight line that is directed at an acute angle from a central axis of the nozzles. The straight beam or stream of liquid emitted from the nozzle is caused to move, by the nozzle's internal construction, in a circulating pattern which creates a conical wall or pattern of liquid 485 which, of course, is circular in transverse cross section as illustrated in Fig. 16. Fast rotating turbo nozzles (approximately 1600 to 2000 revolutions per minute (rps)) are commercially available in several different configurations as described in greater detail below. Slow rotating turbo nozzles, which are not commercially available, can also be specified wherein the speed of rotation is generally 600-1400 rpm. With either the fast or slow rotating turbo variant, the single stream fluid jets emanating from the nozzles appear to form a circular impact ring on the surface of the vehicle as illustrated in Figures 16 and 18. The diameter of the impact rings is dependent on the angle at which the fluid jet leaves the nozzle as well as the distance of

the nozzle from the surface of the vehicle. Although the impact rings shown in dotted lines in Figure 16 are tangential to each other, it is appreciated that depending on the cleaning application, the nozzles specified, and the distance from the cleaning surface, the impact rings may overlap or they may not touch at all. A variant of the turbo nozzle, the oscillating nozzle may also be utilized on the reciprocating wands. As the name suggests oscillating nozzles tend to oscillate back and forth in a generally linear path.

A reciprocating wand assembly of the type described above is also shown in U.S. Patent Application No. 09/698,845 which is of common ownership with the present invention and which is hereby incorporated by reference.

In a one variation on the first alternative embodiment, the reciprocating wand assembly 400 may be connected with a boom comprising twin boom tubes 412 as illustrated in Figure 27. The cleaning solution is delivered to each of the wands 410 from one of the twin boom tubes 412 by a hose 414, as shown. The operation of the wand assembly 400 is substantially the same as described above. Another twin boom variation is illustrated in Figure 28, wherein each of the wands 410 is pivotally connected to a transfer arm 416 that transfers the pivotal motion applied to the first wand by the motor 435 to the other two wands.

### **A Second Alternative Embodiment**

Figures 29-32 illustrate a second alternative embodiment, wherein oscillating or turbo nozzles 705 are attached directly to parallel and spaced boom tubes 710. The cleaning action of the turbo and/or oscillating nozzles 705 ensures complete coverage of the underlying vehicle surface without the utilization of rotating or pivoting wand assemblies. As shown, the boom tubes 710 also double as fluid delivery conduits to carry the high pressure cleaning fluid to the nozzles 705. Preferably, cleaning solution can be routed to either one of the tubes 710

independently of the other, whereby one bank of nozzles attached to one tube can be turned off while the bank of nozzles are turned on. The nozzles may be orientated in a variety of angles relative to the boom tubes 710 depending on the spray pattern of the chosen nozzles. Typically, the boom tubes 710 will be spaced apart from each other a distance of around 18 inches, which has found to be effective in helping ensure complete coverage of the front and rear of a vehicle when the moveable platform is in its lowered position and the boom is tilted. As illustrated, the twin boom tubes 710 are attached to end brackets 715 which are connected to shafts 720 on either end for rotatably attaching the assembly to the gantry for pivotal movement relative thereto. It is appreciated that numerous other pivot boom configurations can be specified in addition to the embodiments and variations described herein as would be obvious to one of ordinary skill with the benefit of this disclosure.

**A Third Alternative Embodiment**

A third alternative embodiment is illustrated in Figures 19 and 20, wherein the tilt of the pivoting boom 245 is directly dependent on the vertical position of the moveable platform 240. Although this system does not offer the same degree of customizability for vehicles of differing profiles, it is less complicated than the preferred embodiment and potentially much less expensive to produce as well. In the third alternative embodiment, a follower arm 505 is keyed to the pivoting boom 245. The follower arm 505 is typically an elongated member that is vertically orientated along its length. The follower arm 505 is attached at an upper end to the pivoting boom 245. The follower arm 505 rides between two opposing guide surfaces 515 formed by framework 510 within the left leg 205 of the gantry structure 105. Near the top of the left leg 205 the wand assemblies 250 are preferably orientated parallel to the ground. Accordingly, the opposing guide surfaces 515 are vertically disposed and spaced from each other a distance only

slightly greater than the width of the follower arm 505. At a predetermined vertical location below the top of the left leg 205, the two opposing surfaces 515 diverge from each other at an acute angle, wherein the opposing guide surfaces 515 viewed together have an inverted Y-shape.

In operation, a biasing force is applied to the pivoting boom 245 to encourage it to rotate clockwise or counterclockwise depending on the location of the gantry 105 relative to the front or rear of a vehicle. It is appreciated that any suitable biasing means may be utilized, including a less sophisticated pneumatic actuator that merely applies a rotational bias to the pivoting boom 245 but is not able to pivot to and hold the pivoting boom 245 at discrete angular orientations.

Next, the moveable platform 240 is lowered as described supra. As the follower arm 505 enters the divergent portion of the guide surfaces 515, the pivoting boom 245 rotates in the biased direction until the lower portion of the arm 505 is in contact with the appropriate guide surface 515. As the pivoting boom 245 is lowered further, it pivots further as controlled by the distance between the center axis of the pivoting boom 245 and the appropriate guide surface 515 relative to the length of the follower arm 505. A maximum possible pivoting movement in either direction of 90 degrees is achieved when the distance between the pivoting boom's axis and the appropriate guide surface 515 is equal to the distance between the center axis and the distal end of the follower arm 505. Based on the operation of this tilting system, it can be appreciated that sensors and a means for measuring and interpreting the sensors concerning the pivotal position of the pivoting boom 245 are not required.

As discussed supra, the embodiments and alternative embodiments described herein are merely illustrative. A number of other alternative embodiments keeping within the scope of the invention as expressed in the appended claims have been contemplated. For instance, either or both the pneumatic reciprocating rotary actuator and the pneumatic lift could be replaced with



mechanical versions. Furthermore, the placement of the various elements of the washing system relative to each other could be varied. For example, rather than having both the pneumatic lift and the reciprocating pivotal actuator located in the right leg, either could be located in the left leg. Additionally, many different types of nozzles may be utilized in the moveable platform  
5 based on considerations of cleaning effectiveness and cost.

### **A Four Pass Wash**

Given the construction of the various embodiments of the vehicle wash system combined with a suitable control system, such as the one described in U.S. Patent Application No. 09/365,519 filed on August 2, 1999 which is commonly owned by the assignee of this  
10 application and is hereby incorporated by reference, a vehicle can be economically and effectively cleaned in four passes including the application of both a clear coat and a spot free rinse solution. This compares to six passes that are typically required during a wash cycle to similarly clean a vehicle using prior art vehicle wash systems. Figure 33 is a flow chart illustrating the operations performed in each pass of a four pass wash cycle according to the  
15 present invention.

First, the vehicle is driven into the car wash bay as indicated by box 605. During a first pass 610, the gantry moves along and over the vehicle, typically from the front of the vehicle to the back, spraying the vehicle with a presoak solution from the presoak nozzles 242. Also during the first pass, the length of the vehicle is determined and relative height of the vehicle is profiled  
20 for reasons that will become apparent below.

During a second pass 615, the gantry travels back beyond the front of the vehicle. During the time it takes for the gantry to travel from the back to front, the presoak solution has time to penetrate and loosen any dirt on the vehicle's surface.

During the third pass 620 water under high pressure is sprayed from the both the side and top high pressure nozzles 230 and 256. As described above, the side nozzles 230 can comprise a lower set of rocker panel nozzles 230A, a set of middle turbo nozzles 230B and a set of upper turbo nozzles 230C. As the gantry passes over the hood of a typical vehicle, both the middle set of nozzles 230B and the rocker panel blasters 230A are activated, and depending on the height of the hood and trunk, the upper set of nozzles 230C may not be activated. If the vehicle has a low hood/trunk height, the solenoid valve connected to the upper set of nozzles will close to prevent cleaning solution from needlessly being sprayed over the top of the hood and trunk. On the other hand, if the hood and/or trunk has a high profile then the upper nozzles 230C will be activated as the clearance eye sensor 232 located on one of the gantry legs senses the increased height of the vehicle. As the gantry passes over the middle portion of the vehicle, the rocker panel, middle and upper nozzles are all typically activated. Next, as the gantry passes over the back of the vehicle the upper set of nozzles 230C may be deactivated if the vehicle has a low trunk as typically would be the case with a sedan.

Before the Gantry passes over the vehicle during the third pass, the moveable platform 240 is lowered until it is in front of the front of the vehicle and the pivoting boom 245 is rotated until the upper nozzles 256 face the front of the vehicle. The nozzles 256 are activated and the front of the vehicle is impacted by jets of fluid as the platform 240 is raised. Once the platform 240 has been raised above the height of the front end, the pivoting boom 245 is rotated back to its unpivoted centered position with the nozzles 256 facing downwardly. Next, the gantry during the third pass passes over the hood of the vehicle with the nozzles 256 spraying jets of water downwardly. Depending on the height of the hood the movable platform 240 may be held in a position below the retracted position such that the distance between the hood and the nozzles 256

is reduced. As the gantry passes over the windshield, the moveable platform 240 rises to clear the roof and/or maintain a preferred distance between the nozzles 256 and the top surface of the vehicle. Depending on the height of the rear portion of the vehicle, the platform 240 may again be lowered to maintain a preferred distance between the surface of the rear deck and the nozzles 256. Finally, the gantry moves behind the vehicle and the moveable platform 240 is lowered until it is located behind the back of the vehicle. Simultaneously, the pivoting boom 245 is rotated so that the nozzles 256 face the front of the vehicle. Once the backside of the vehicle has been washed, the boom 245 rotates back to its neutral position and the moveable platform 240 ascends to its retracted position.

During the forth pass 625, the gantry is moved from the back of the vehicle towards its initial position in front of the vehicle. Both a clear coat and a spot free rinse are applied in the manner described previously. Fifth and sixth optional passes may be included wherein a dryer apparatus 220 mounted on the gantry dries the vehicle. Alternatively, stationary blowers may dry the vehicle as it passes out of the wash bay. It is also appreciated that a three cycle wash may also be run in which the forth pass is not utilized.

It is appreciated that any number of sensor arrays maybe utilized to determine the profile of the vehicle being washed. The preferred embodiment, however, utilizes a clearance eye sensor 232 and front and rear locator sensors 233 and 234, as illustrated in Figure 2. The clearance sensor eye 232 is located on one of the legs of the gantry in a vertical position below the lowest overhead deployed position of the moveable platform 240. Typically, the clearance sensor 232 will be positioned approximately 40 to 46 inches off the floor of the vehicle wash bay. If the “beam” of the sensor 232 is broken, it indicates a portion of a vehicle with a height above the height of the clearance sensor, and the upper set of side nozzles 230C are typically activated by

the control system. If the beam is intact, a lower portion of the vehicle is indicated, causing the control system to lower the moveable platform 240 and to deactivate the upper set of side nozzles 230C.

The front and rear sensors 233 and 234 indicate whether the gantry is in front of or behind the vehicle. Typically, these sensors are located closer to the floor on one of the gantry legs, the front sensor 233 proximate the front face of the gantry, and the rear sensor 234 proximate the rear face of the gantry. An unobstructed sensor “beam” indicates that the gantry is either in front of or behind the vehicle. Typically, when both beams become unobstructed the control system recognizes the gantry is either in front of or behind the vehicle and it then travels an additional predetermined distance in its direction of travel to ensure it is behind or in front of the vehicle enough to allow operation of the moveable platform 240 and pivot boom 245 to clean the respective front or rear end of the vehicle.

### **Turbo and Oscillating Nozzles**

As described above various types of high pressure nozzles are utilized in the various embodiments of the present invention, including zero degree nozzles, fast rotating turbo nozzles, slow rotating turbo nozzles, and oscillating nozzles. Zero degree nozzles are well known in the art and are commercially available from a variety of vendors. Typically, zero degree nozzles shoot a single jet of fluid from a fixed orifice, such that each they impact on a relatively small area on the surface of a vehicle when used in conjunction with a vehicle wash system.

Accordingly, they are typically utilized with rotating wands that move the nozzles over the surface of the vehicle to obtain complete coverage of the associated surface, such as the rotating wand assemblies described concerning the first embodiment. Given the high integrity of the fluid

jets that emanate from Zero degree nozzles, they typically have a maximum effective range of up to 80 inches.

As illustrated in Figure 34, both the fast and slow rotating turbo nozzles comprise a rotating nozzle member 805 that has an orifice 810 that rotates within the body 815 of the nozzle causing the fluid jet emanating therefrom to assume a spiral shape as illustrated in Figure 16.

This causes a single turbo nozzle to have a circular impact area, which makes obtaining complete coverage of the vehicle surfaces simpler. For instance, in certain circumstances, the use of fast rotating turbo nozzles 405 with the reciprocating wand assemblies 400 of the second alternative embodiment result in better coverage of the vehicle surfaces and more effective cleaning of the surfaces than the zero degree nozzles used with the rotating wands of the first embodiment.

Furthermore, by substituting fast rotating turbo nozzles for the zero degree nozzles in the rotating wands of the first embodiment, multiple impacts of the stream with the automobile surfaces results for improved cleaning performance. The versatility of the fast rotating turbo nozzle is also demonstrated by the second alternative embodiment where the use of reciprocating wands are eliminated, since turbo nozzles with spray patterns that overlap at least partially can effectively clean the entire top surface of a vehicle when combined with the movement of the gantry over the vehicle. It is also noted that the series of turbo nozzles located on either leg of the gantry effectively replace side wand assemblies utilizing zero degree nozzles without a reduction in cleaning effectiveness. Another advantage of turbo nozzles generally is there ability to operate effectively at lower pressures than the typical zero degree nozzle. Whereas, zero degree nozzles generally require pressures of around 900 psi or greater, typical turbo nozzles can operate at pressures of as low as 600 psi.

Fast rotating turbo nozzles, in which the nozzle orifice rotates at speeds of round 1600 to 2000 rpm, are commercially available in a variety of sizes from several vendors and have been utilized in various applications on vehicle wash systems. However, fast rotating turbo nozzles suffer from a drawback that has limited their application in certain vehicle wash system

5 applications, namely, they have a limited effective range of 28" to 36" depending on the size of the fast rotating nozzle specified. At distances in excess of the effective range, the spiraling fluid jet loses its integrity and becomes a mist, which although increasing the coverage of the underlying surface, does not impart enough of an impact force on the vehicle to effectively dislodge dirt and debris. It can be appreciated that the total distance traveled by any portion of cleaning solution in a spiraling fluid jet as it spirals towards a vehicle's surface is much greater than the distance between the nozzle orifice and the surface to be cleaned. In other words, the length of an uncoiled spiraling jet would be much greater than the distance between the nozzle tip and the surface of the vehicle. It follows, therefore, that the aerodynamic drag incident on a spiraling fluid jet from mist and air would be significantly greater than on a comparable straight fluid jet (such as from a zero degree nozzle). This aerodynamic drag tends to dissipate some of the spiraling jets energy. Furthermore, the complex force vectors acting on the spiraling fluid jet as it leaves the nozzle and travel towards the vehicle surfaces tends to compromise the integrity of the spiraling jet contributing to its effective disintegration at much short distances than a comparable straight fluid jet.

20 Slow rotating turbo nozzles of the present invention as their name would suggest rotate at greatly reduced rate of around 600-1400 rpm when compared to their fast rotating cousins. The fluid jets emanating from them spiral at a significantly slower rate than their fast rotating cousins, making less turns before reaching the surface of the vehicle. The distance traveled by

any portion of the fluid jet from a slow rotating turbo nozzle would be less than that of a jet from a fast rotating nozzle situated a similar distance from a vehicle surface. The fluid jet of a slow rotating turbo nozzle would, therefore, encounter less energy dissipating aerodynamic drag than its fast rotating cousin and the energy of the fluid jet from the slow rotating turbo nozzle would dissipate less than the fluid jet from the fast rotating turbo nozzle. Accordingly, a slow rotating turbo nozzle has a greater effective range (similarly sized fast and slow rotating turbo nozzles have approximate ranges of 36" and 42" respectively). Even at distances within the effective ranges of the fast rotating turbo nozzle, the slow rotating turbo nozzles delivers a fluid jet having a greater impact force per unit area than the comparable fast rotating turbo nozzle. By using slow rotating turbo nozzles in a vehicle wash system, all surfaces of the vehicle can be hit with jets of cleaning solution at effective levels of impact force to dislodge most dirt and debris, especially those on contoured surfaces of a vehicle that might be outside of the range of fast rotating turbo nozzles.

Figures 34-40 and Figure 42 illustrate a slow rotating turbo nozzle. Furthermore, Figure 41 illustrates a cross section of a fast rotating turbo nozzle for purposes of comparison. Unless otherwise indicated, the description proved herein generally applies to both fast and slow rotating turbo nozzles. Distinctions between the fast and slow turbo nozzles will be specifically indicated.

As shown in Figure 34, A typical turbo nozzle comprises three basic components: a nozzle body 815; an inlet cap 820 that is threadably received into the top of the body; and a rotating nozzle member 805 that is contained within the body. The hollow nozzle body 815 has a generally conical shape beginning with a threaded opening to receive the inlet cap 820 at a distal end. From the distal end, the walls of the body 815 taper until terminating at the proximal end in a ceramic seat 825. The ceramic seat 825 has a concave inside surface configured to receive the

orifice of the rotating nozzle member and a passage 830 therethrough to permit the fluid jet emanating from the orifice to exit the turbo nozzle.

The inlet cap 820 is a generally cylindrical member having a partially threaded outside surface for being received into the threaded opening of the nozzle body 815 with an o-ring seal 835 disposed thereon. The inlet cap 820 further comprises a vertical bore 840 that is partially threaded for coupling with a cleaning solution supply manifold or hose. The bore is closed at its bottom end; however, one or more small jet passageways 845 extend through the vertical wall of the bore 840 at generally acute angles and into the interior of the nozzle body 815 as illustrated in Figure 37. The angles that the one or more passageways 845 extend through the wall, the diameter of the passageways and the interaction between the fluid jets emanating therefrom during operation are all critical in determining the rotational speed of the turbo nozzle as will be described below. Lastly, A small nib 850 extends from the center of the outside surface of the closed bottom end of the inlet cap 820 for reasons that will become apparent.

The rotating nozzle member 805 is illustrated in isolation in Figures 35 and 36. The rotating nozzle member 805 typically comprises a brass tube 855 having a perforated support piece 860 spanning the interior of the tube proximate its distal end to provide support and additional strength thereto. The distal end of the tube is capped with a ceramic orifice 810 from which the spiraling jet of the turbo nozzle emanates. The ceramic orifice 810 has a generally conical shape that terminates in a rounded end. The rounded end is sized to nest in the concave portion of the ceramic seat 825 such that when under pressure the ceramic orifice 810 effectively seals the passage through the ceramic seat 825. The diameter of the ceramic orifice 810 ultimately controls the volumetric output of the nozzle.



The outside surface of the brass tube 855 is covered by one or more plastic shrouds 865, 870 and 875. In general, the plastic shrouds serve to protect the brass tube 855 as the nozzle member 805 is rotated within the nozzle body 815 at high speeds. Depending on the particular configuration of the turbo nozzle, a single unitary plastic shroud maybe utilized, although as illustrated, three separate and distinct shrouds 865, 870 and 875 are indicated. The upper shroud 865 serves to guide the nozzle member 805 around the nib 850, as best illustrated in Figures 34 and 38. The middle shroud 870, which is shown having a hexagonal outer surface, serves to guide the nozzle member 805 along the inside surface of the nozzle body 815 as best illustrated in Figure 39. Because the middle shroud 370 is hexagonal, it will cause the orifice 810 to rotate in a more hexagonal pattern, thereby altering the characteristics of the fluid jet emanating therefrom. Furthermore, the hexagonal surface of the middle shroud 870 will not rotate as easily around the inside surface of the nozzle body 815, thereby increasing the rotational friction of the nozzle member 805, slowing its effective rate of rotation even further. As illustrated in Figure 40, the hexagonal shroud 370 can be replaced with a circular shroud 870A in variations thereof.

The operation of a typical turbo jet will now be described. First, the cleaning solution enters the inlet cap 820 from a source under high pressure. The cleaning solution then travels through the one or more passageways 845, wherein the cleaning solution is accelerated and is propelled from the nozzles as a stream in a direction generally perpendicular with the center axis of the turbo nozzle towards the corresponding inner surface of the body 815. The stream impacts inner surface of the body 815 at an acute angle, which induces the cleaning solution to rotate in a clockwise direction. A clockwise vortex of cleaning fluid is created within the body 815 which is completely filled with the pressurized cleaning solution during operation. By reversing the angle of incidence between the stream and the wall of the body, a counterclockwise vortex could be

created as well. The vortex causes the nozzle member 805, which is in its path, to rotate at essentially the same velocity as the vortex. It is appreciated that the nib 850 prevents the nozzle member 805 from positioning itself in the calm center of the vortex. Next, the pressurized cleaning fluid contained in the body is forced into the top end of nozzle tube 855 and through the orifice 810, wherein the cleaning solution is accelerated and exits the nozzle in the form of a spiraling fluid jet.

The speed of rotation of the nozzle and the speed of rotation of the fluid jet emanating therefrom is directly related to the rotational velocity of the vortex created within the nozzle body 815. The velocity of the vortex is dependent on both the angle at which the fluid streams emanating from the inlet cap passageways 845 are incident on the inner surface of the body wall, as well as, the velocity of the streams. A horizontal cross section of a typical fast rotating turbo nozzle showing a single passageway 845 through the bore 840 in the inlet cap 820 into the body of the nozzle is illustrated in Figure 41. A corresponding section of a slow rotating turbo nozzle is illustrated in Figure 42, wherein four passageways 845 are shown. The four passageways 845 have a combined cross sectional area greater than that of the single passageway 845 of fast rotating turbo nozzle of Figure 41. For a given pressure of fluid being passed through the passageways of both nozzles, the fluid stream emanating from the passageway of the fast rotating nozzle will be faster than the streams emanating from each of the passageways of the slow rotating turbo nozzle. Accordingly, the rotational speed of the vortex created in the slow rotator will be less than the speed of the vortex in the fast rotator, resulting in a slower rotating nozzle member.

Other means of creating a slow rotating turbo nozzle are also contemplated. For instance, a set of one or more passageways 845 could pass through the inlet cap 820 at one angle while a

second set of one or more passageways could pass through the inlet cap at a second angle, such that the streams emanating from the second set interfere with the vortex caused by the streams from the first set such that the speed of the vortex is reduced. For instance, streams from the first set of passageways 845 may induce a clockwise rotating vortex in the nozzle body 815 having a speed comparable to that of a vortex in a fast rotating turbo nozzle. The streams from the second set of passageways may exit the passageways at angles that would by themselves induce a counterclockwise rotation. The combination of these two sets of streams effectively results in a vortex of a reduced speed. It is to be appreciated that a wide variety of combinations of sets of passageways can be utilized to tailor the speed of the vortex and consequently the rotational speed of the turbo nozzle to a desired level.

Another type of nozzle used in embodiments of the present invention is an oscillating nozzle as shown in Figure 43. The fluid jet emanating from the oscillating nozzle differs from the fluid jet of turbo nozzle in that instead of spiraling, it moves back and forth in a generally linear path as illustrated in Figure 43. Oscillating nozzles with small nozzle bodies 915 are commercially available, which oscillate at a relatively fast rate; whereas, slower oscillating nozzles having large bodies 915 are not commercially available, although both designs operate in a similar manner as described herein. The oscillating nozzle has an inlet cap 920 and body 915 generally very similar to those on a turbo nozzle except the ceramic seat 925 is not fixed to the body 915, rather it is fixed to the lower portion 970B of a housing 970 contained within the body 915. The tube 955 to which the orifice 910 is affixed is does not spin, nor does it rotate about a nib (not shown) on the inlet cap 920. Rather, it is permitted only to pivot side within a slot 975 in the lower portion 970B of the nozzle member housing 970. The lower portion 970B of the nozzle member housing 970 is fit into an opening in the base of the body 915 such that it cannot

spin but it can pivot slightly. An upper portion 970A of the housing portion is connected to the lower portion 970B, thereby surrounding the nozzle tube. The attachment of the upper portion 970A with the lower portion 970B prevents it from spinning; however, it is free to rotate about the nib on the inlet cap 920 in a fluid vortex created in the body 915. Rotation of the upper  
5 portion 970A of the housing causes it to impact an o-ring 980 circumscribing the brass tube 955 proximate its top end causing the orifice 910 to pivot back and forth in the slot 975.

In general, the effective range (approximately 45") of the oscillating nozzles is greater than that of the turbo nozzles; however, the range of faster small body oscillators is less than that of a slower large body oscillator. It is to be appreciated that the speed of oscillation is directly  
10 related to the velocity of the vortex created in the nozzle body and the distance that the vortex must travel to complete a revolution of the inside of the body 915. It follows that the speed of oscillation may be reduced by (1) increasing the size of the nozzle body whereby the vortex has a greater distance to travel to complete a revolution, or the Accordingly and/or (2) using the same  
15 types of modifications to the inlet cap passageways 945 as described above for turbo nozzles to slow the velocity of the stream emanating from passageways 945.

Although the present invention has been described with a certain degree of particularity, it is understood that the present disclosure has been made by way of example, and changes in detail or structure may be made without departing from the spirit of the invention as defined in the appended claims.